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Case Report

Ruptured middle cerebral artery bifurcation aneurysm manifesting as caudate head hemorrhage extending into the ventricle: case report and literature review

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Abstract: Ruptured intracranial aneurysm usually manifests as subarachnoid hemorrhage (SAH) or SAH with hematoma. Aneurysms that only present with intracerebral hemorrhage or intraventricular hemorrhage are mostly confined to the distal artery. It is very rare that ruptured middle cerebral artery bifurcation aneurysms manifest signs of caudate head hemorrhage extending into the cerebral ventricle. One such case was reported in this paper. A 48-year-old man experienced an abrupt episode of headache and dizziness. Computed tomography (CT) showed caudate head hemorrhage that extended into the cerebral ventricle. CT angiography (CTA) and digital subtraction angiography (DSA) revealed ruptured middle cerebral artery bifurcation aneurysms to be the cause of the intracranial hemorrhage. A favorable outcome was achieved after surgical clipping. During surgery, this aneurysm was located in a deep region adjacent to the insular lobe surface and close to the caudate head. This ruptured aneurysm caused caudate head hemorrhage extending into the cerebral ventricular system. Upon a retrospective review of the literature, we concluded that this unique bleeding pattern was due to the projection of the aneurysm; this aneurysm was uniquely anteriorly projected and attached to caudate head. When the aneurysm ruptured, blood extended into the cerebral ventricular system through the caudate head. Thus, SAH was not present. These findings suggest that ruptured aneurysms originating from main branches of the cerebral artery in certain rare conditions, such as the middle cerebral artery bifurcation aneurysm in this case, could only manifest as an intracerebral hemorrhage extending into the ventricle. Attention should be paid to these rare cases, and CTA should be performed on a regular basis to avoid a misdiagnosis.

Keywords: Middle cerebral artery, aneurysm, caudate head hemorrhage, cerebral ventricle

The imaging of intracranial aneurysms may vary according to their location. Presentations of isolated subarachnoid hemorrhage (SAH) are more common if the aneurysm originates from the Willis ring or the branching site of the vertebrobasilar artery, whereas signs of isolated SAH or SAH with intracranial hematoma may be present if the aneurysm originates from a cistern of the lateral cerebral fossa or an interhemispheric fissure [1]. Signs of intracranial hematoma are only present when the aneurysm is located at the distal artery; intraventricular hemorrhage is associated with aneurysms that are close to the cerebral ventricular system [2, 3]. It is very rare for a ruptured middle cerebral artery bifurcation aneurysm to manifest as a caudate head hemorrhage extending into the intra-ventricle. A rare case of middle cerebral artery bifurcation aneurysm was reviewed in this study. The ruptured aneurysm manifested as a caudate head hemorrhage extending into the cerebral ventricle and was very different from common types of aneurysms. We wanted to address this case because it could very easily be misdiagnosed as an isolated intracerebral hemorrhage, which may cause a diagnostician to miss the optimal timing of intervention.

Case report

A 48-year-old male was admitted with complaints of “abrupt headache, dizziness, nausea, and vomiting for 1.5 hours”. His previous history was unremarkable. He denied family histories of cerebral hemorrhage, hypertension and

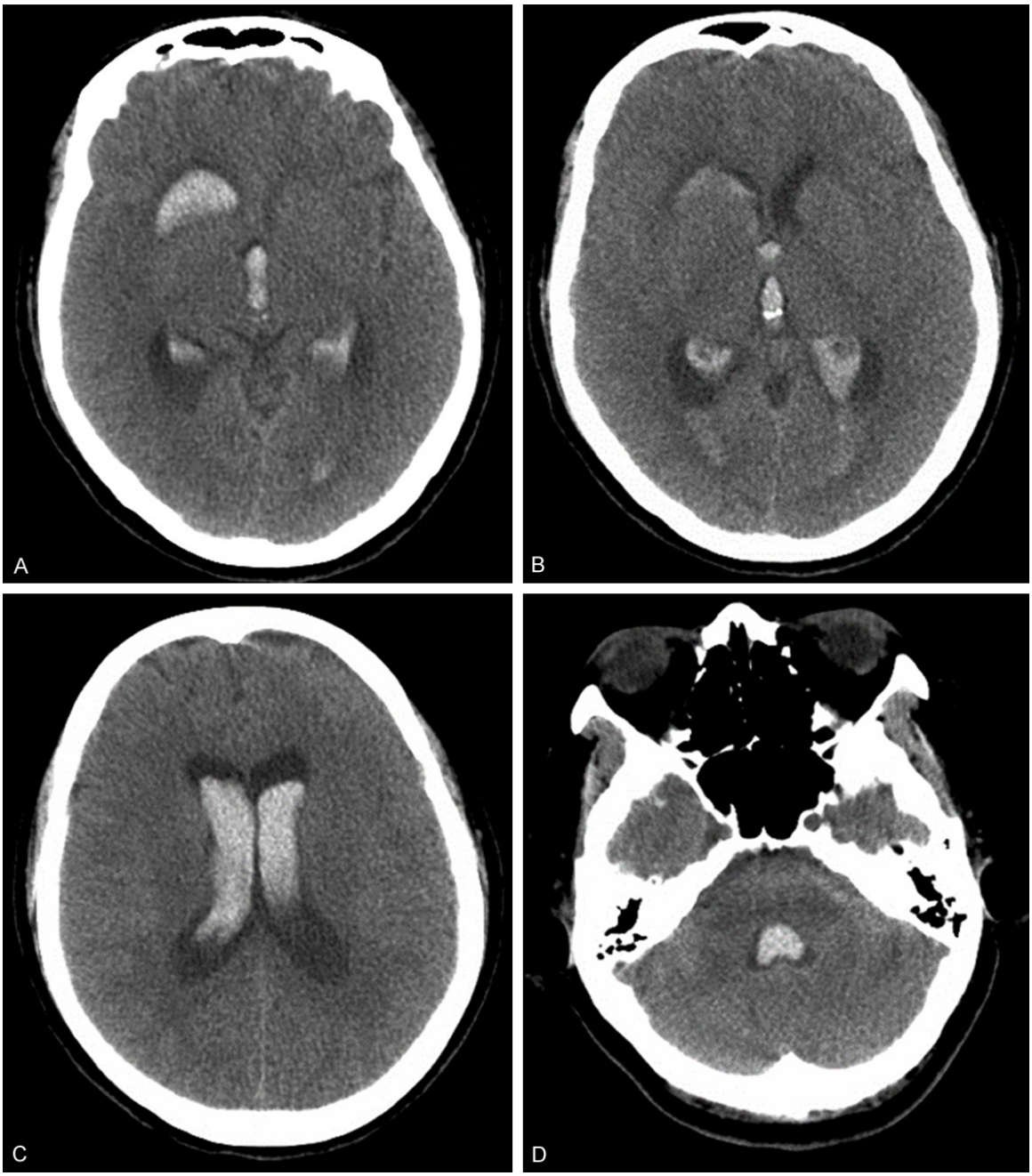

Figure 1. Head CT images. A, B: A caudate head hemorrhage extending into the frontal horn of the lateral ventricle and entering the third ventricle through the interventricular foramen. C: Blood filling the bilateral lateral ventricles. D: Bleeding into the fourth ventricle.

diabetes. On physical examination, his vital signs were stable, his blood pressure was 130/80 mmHg, he was conscious and answered questions accurately, he could move his extremities on command, stiff neck was noted, the Kernig sign was positive, and no other positive signs of nervous system involvement were remarkable. Emergent head computed tomography (CT) revealed that a right caudate head hemorrhage extended internal-laterally into the lateral ventricle and entered the third and fourth ventricles through the interventricular foramen (**Figure 1**). Concurrent CT angiography (CTA) revealed that the right middle cerebral artery bifurcation aneurysm, which was cystic and had a finger-like shape, was anteriorly pro-

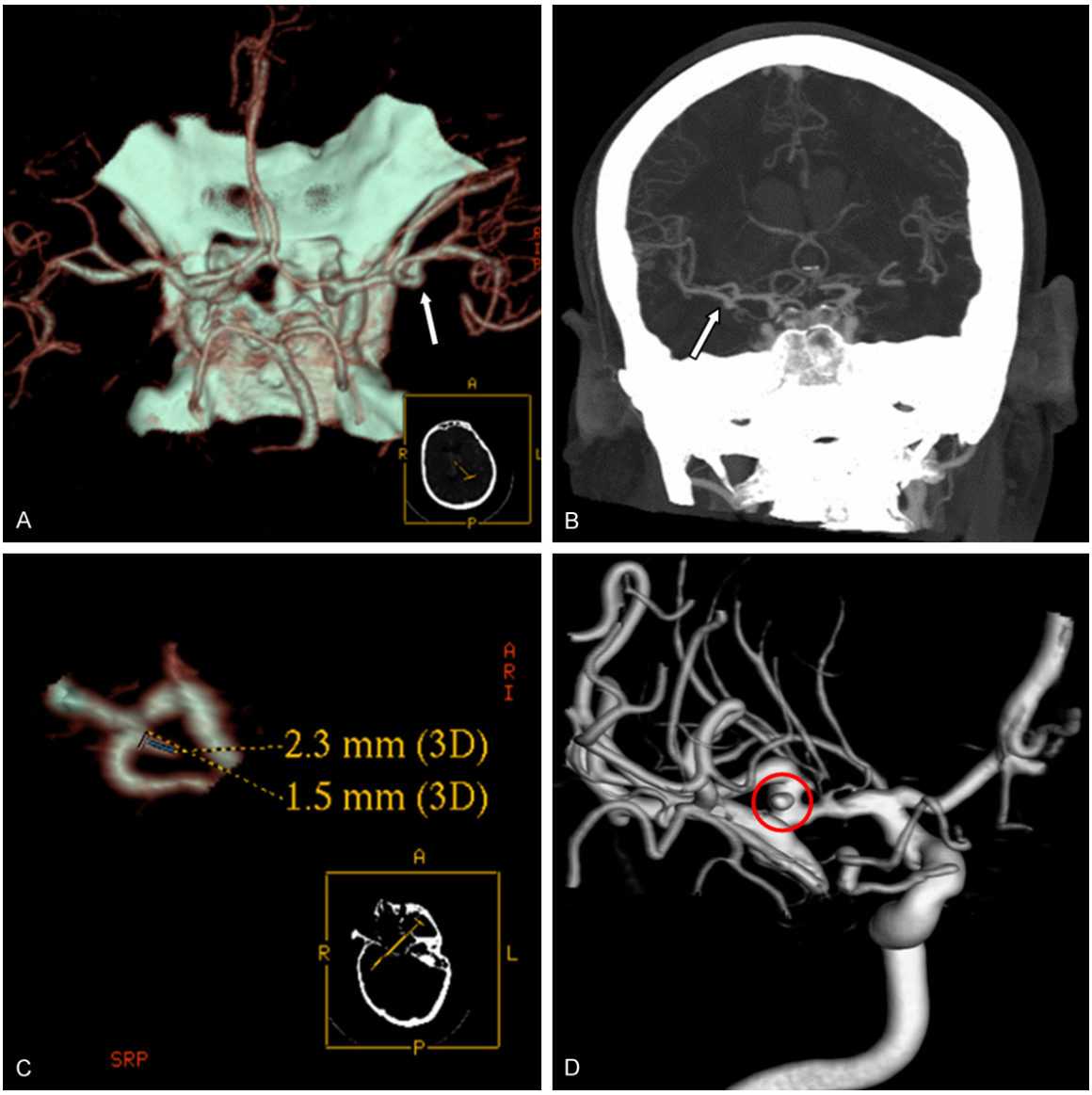

Figure 2. Images of the aneurysm. A: CTA revealing a right middle cerebral artery bifurcation aneurysm (white arrow). B: Maximum-intensity image of a CTA showing the relationship between the aneurysm and the intracranial hematoma, which extends into the lateral ventricle from the artery. C: CTA showing the details of the aneurysm; the aneurysm is finger-shaped and 2.3 mm×1.5 mm in size. D: Three-dimensional DSA reconstruction imaging showing the aneurysm (anteroposterior view) projecting anteriorly (red circle).

jected and that the aneurysm size was approximately 2.3 mm × 1.5 mm; additionally, maximum-intensity images revealed that a hematoma was bleeding into the lateral ventricle through the caudate head and further into the third and fourth ventricles (**Figure 2A-C**). On further head digital subtraction angiography (DSA), three-dimensional reconstruction imaging revealed that the aneurysm originated from the middle cerebral artery and was projected anteriorly (**Figure 2D**). According to the CT and DSA imaging, the diagnosis was confirmed as a right middle cerebral artery bifurcation aneurysm and a right caudate head hematoma extending into the cerebral ventricle. Aneurysm clipping were performed. During surgery, conventional right pterional craniotomy was selected as the surgical path. After the separation of the lateral fissure, the middle cerebral artery bifurcation was exposed, and the cystic aneurysm was located in a deep region of the lateral fissure. The aneurysm projected anteriorly, attached to the insula lobe, and was adjacent to the caudate head. The rupture site was on

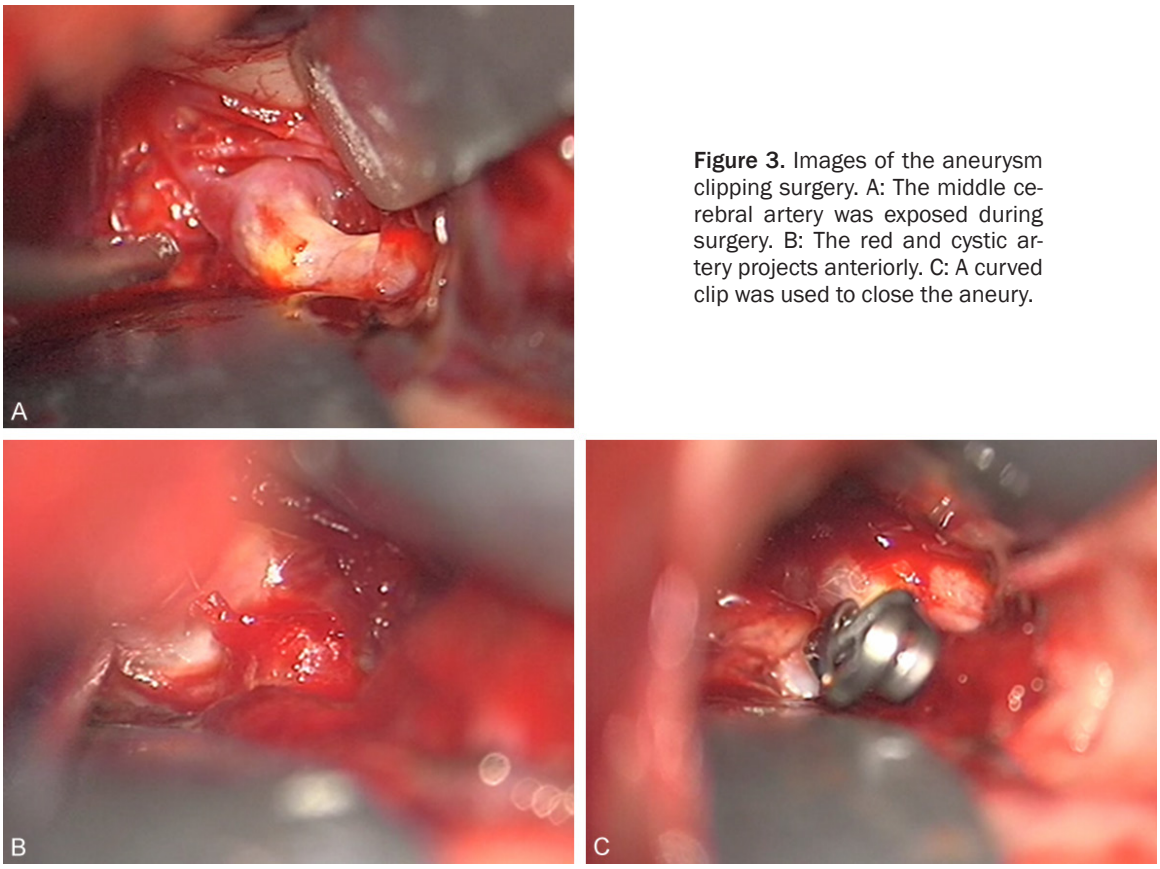

Figure 3. Images of the aneurysm clipping surgery. A: The middle cerebral artery was exposed during surgery. B: The red and cystic artery projects anteriorly. C: A curved clip was used to close the aneury.

the medial side of the anterior portion of the aneurysm. After the clear exposure of the aneurysm, a curved aneurysm clip was used to close the aneurysm neck, and the closure was completed without residual aneurysm (**Figure 3**). The hematoma was deeply located and was difficult to expose. Thus, the removal of the hematoma was not performed. The patient was immediately returned to consciousness after surgery. On examination, his extremity activities were normal. Lumbar puncture was performed 2 hours after surgery, and continuous lumbar cistern drainage was initiated and continued for one week. Multiple repeated CT scans were performed after surgery. On the 10th day, CT showed intraventricular hematoma absorption and no sign of hydrocephalus. After 15 days of hospitalization, the patient was discharged after recovery. No positive signs of nervous system involvement were noted on discharge. Six months after discharge, the patient returned to work as normal as his previous condition. A follow-up CTA revealed no signs of recurrent aneurysm and complete clipping. The follow-up was continued for another 2 years by phone and indicated that the patient was in good health.

Discussion

The intracranial blood supply can be divided into anterior and posterior circulation based on the brain anatomy. The anterior circulation mainly refers to the intracranial carotid artery system, while the posterior circulation mainly refers to the vertebrobasilar system. These intracranial arteries are distributed on the bottom surface of the brain and are also located in the subarachnoid space [4]. Most aneurysms originate from the site of the intracranial main artery, which gives rise to branches such as the top of the basilar artery, the anterior communicating artery complex, the originating part of the posterior communicating artery and the middle cerebral artery bifurcation. These sites are located in the subarachnoid space; ruptured aneurysms in these sites manifest as subarachnoid hemorrhages (SAHs). Therefore, the presentation of SAH is a typical imaging finding of ruptured intracranial aneurysms [5,

6]. In addition to isolated SAH, some ruptured aneurysms are also associated with intracerebral hematoma. In other words, it is not uncommon for ruptured aneurysms to be associated with intracerebral hematoma formation. In 2015, Talamonti et al. reported that the incidence of intracerebral hematoma in cases of aneurysm rupture ranged from 4% (in low-grade patients) to 25% (in high-grade patients) and up to 84% in the autopsy series [7]. The major reason for the formation of intracerebral hematoma is that some arteries run through the deep fissures after branching from the main artery, such as the M1-M3 segment of the middle cerebral artery in the lateral fissure and the A2-A5 segment of the anterior cerebral artery in the inter-hemispheric fissure. If aneurysms form in these sites, bleeding is difficult to diffuse in the subarachnoid space in a short period of time due to the deep location of the aneurysm. In addition to the occurrence of SAH, a hematoma will form at the site of the aneurysm [8-10]. SAH is the typical manifestation of a ruptured aneurysm. Therefore, regardless of whether SAH is accompanied by intracerebral hemorrhage, CTA or DSA is required to rule out aneurysm.

Ruptured aneurysms can cause SAH or SAH with intracerebral hematoma. However, signs of SAH may be absent in ruptured aneurysms that originate from certain unique sites. Instead, signs of intracerebral hematoma or isolated intraventricular hemorrhage may be present. In 2009, Yurt et al. reported a case of an anterior choroidal artery aneurysm that developed a temporal lobe hematoma and extended into the lateral ventricle [11]. In 2011, Ellis reported a case of a ruptured lenticulostriate artery aneurysm that only presented with intraventricular hemorrhage [12]. Additionally, in 2013, Srivastava reported a case of a ruptured lenticulostriate artery aneurysm that presented as an isolated intraventricular hemorrhage [13]. Additionally, in 2003, Yamakawa reported a case of ruptured aneurysm of the distal middle cerebral artery that manifested as an intracerebral hemorrhage and a subdural hematoma [3]. Fungal infection may be the cause of this type of aneurysm [14]. A retrospective analysis of these case reports has revealed that these aneurysms are located at the distal artery; thus, ruptured aneurysms may not cause SAH due to their deep locations in the cerebral tissue. For example, in patients with Moyamoya disease, the rupture of a perforating artery aneurysm or a distal anterior choroidal artery aneurysm will more likely cause intraventricular hemorrhage or intracerebral hematoma. In 2010, Yang et al. reported a case of Moyamoya disease with distal anterior choroidal artery aneurysm rupture that caused intracerebral hematoma and intraventricular hemorrhage but not SAH [15]. In 2014, Zhang et al. reviewed cases of aneurysms associated with Moyamoya disease and found that the majority of perforating artery aneurysm ruptures only cause intracerebral or intraventricular hemorrhage, in contrast with common intracranial aneurysm ruptures, which cause SAH [16].

In summary, the rupture of an aneurysm originating from an intracranial main artery bifurcation may cause SAH; an aneurysm from an artery located in the lateral or interhemispheric fissure may cause SAH with intracerebral hematoma; a distal arterial aneurysm located in the brain or periventricular tissue may only manifest signs of intracerebral hematoma or intraventricular hemorrhage. According to the above-mentioned pattern, middle cerebral artery bifurcation aneurysm ruptures can cause SAH or SAH with intracerebral hematoma, depending on the anatomical location of the aneurysm in the brain [9]. However, in extremely rare conditions, middle cerebral artery bifurcation aneurysm ruptures may only manifest as intracerebral hemorrhages, such as in the case in this report. A patient with an unremarkable history developed an artery aneurysm rupture. A head CT revealed that a caudate head hemorrhage extended into the lateral ventricles. CTA and DSA revealed a middle cerebral artery bifurcation aneurysm. CTA maximum-intensity imaging revealed that a hematoma was bleeding into the lateral ventricle through the caudate head after aneurysm rupture. Surgery confirmed that hemorrhage was caused by aneurysm rupture. Along with a literature review, we report this rare case and discuss why middle cerebral artery bifurcation aneurysms only cause intracerebral hematomas. The significance of this finding is that it can aid in recognizing unique clinical manifestations caused by artery aneurysm ruptures.

Further analysis of this case with middle cerebral aneurysm rupture causing intracerebral hematoma extending into the ventricle found that the projection of this aneurysm was rela-

tively unusual: this aneurysm projected anteriorly and attached closely to the insular lobe surface. The caudate head was located on the internal side of the aneurysm. The projection of this aneurysm was different from those in most cerebral artery bifurcation aneurysms. The majority of middle cerebral artery aneurysms project along with the direction of blood flow, namely, the direction the main middle cerebral artery travels [17]. The projection of this aneurysm is the anatomic basis of this particular bleeding pattern. In this case, when bleeding occurred on the top of the aneurysm, the blood burst into the internal-lateral caudate head, penetrated through the thin caudate head and extended to the cerebral ventricle until the bleeding stopped, which explained the particular hemorrhage pattern. Because of existence of a pressure gradient from the ruptured aneurysm to the ventricle system, the blood flow did not reflux into the subarachnoid space. Briefly, in extremely rare conditions, middle cerebral artery bifurcation aneurysms can cause isolated intracerebral hematomas extending into the cerebral ventricle without signs of SAH.

In conclusion, the imaging manifestation of ruptured intracranial aneurysms may vary, but signs of SAH are more common in main artery branch aneurysms. Some arteries run through deep fissures, such as the lateral or the interhemispheric fissure, and ruptured aneurysms originating from these arteries may manifest signs of SAH with intracerebral hematoma. Ruptured aneurysms originating at the distal or perforating artery may manifest signs of intracerebral hematoma or intraventricular hemorrhage. All of the above manifestations of hemorrhage are common. However, in extremely rare conditions, certain ruptured aneurysms originating from main branches of arteries, such as a middle cerebral artery bifurcation aneurysm, can only manifest as intracerebral hemorrhage extending into the cerebral ventricle. Attention should be paid to this type of case.

Disclosure of conflict of interest

None.

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